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Cover: Ornate box turtle, *Terrapene ornata*. Photograph of a captive animal by Michael Redmer. (This turtle was adopted through the CHS more than ten years ago.)

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Herpetological Art in the Indianapolis Zoo and the Adjacent White River Gardens

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This is about statues and other three-dimensional art.



On Memorial Day weekend of 2019, the Indianapolis Zoo added a black mamba (*Dendroaspis polylepis*) display, among other new exhibits, to the Desert Biome where they keep their reptiles. The new displays were heavily advertised in the media for several months. Right above the snake's cage is a nice three-dimensional sign that shows a black mamba crawling through the word "Mamba." This sign is several feet long. I don't know what material the sign is made from but it's a good representation of the snake.



Along the trail that winds through the Forest exhibits, which include the American bald eagle, *Haliaeetus leucocephalus*, there is a statue of some kind of crocodile that is approximately 10–12 feet long. I don't know if this is meant to represent a certain species and I don't know what material this was made

from. From how much this statue has weathered, it looks like it's been there for quite some time. At the back of the crocodile's mouth is a tube into which the public is encouraged to toss coins. Right next to the crocodile is a sign that says "Make a Wish for Wildlife. All proceeds go towards the American Association of Zookeepers." I don't know how the zoo retrieves the money.





Right next door to the Indianapolis Zoo is the White River Gardens, a botanical garden. At one outdoor area are four displays, each one about the size of a two-car garage. These displays have plants, and at each corner are bronze statues of animals approximately 15 inches tall. One of the animals is a turtle that is shown in a sort-of sitting position. Another animal is a frog that is also shown in a sitting position. Other non-herp animals include a squirrel and a rabbit. All of these figures are cartoon-like caricatures.



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A Brief History of the American Literature and a Collection Note on *Takydromus tachydromoides* (Family Lacertidae)

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My visit to Japan in May 1977 helped stimulate my herpetological career. While there I had the opportunity to visit the Japan Amphibian Laboratory, Nikko, Japan (Honshu Prefecture) where Dr. Naotugu Shinozaki gave me several live and preserved specimens of Japanese members of Asiatic salamanders of the family Hynobiidae: *Hynobius kimurae*, *H. lichenatus*, *H. nigrescens*, *H. tokyoensis* and *Onychodactylus japonicus*. Several papers were published on these collections and future legal importations. I also had the opportunity to collect reptiles in Fujisawa, Japan (Kanagawa Prefecture), which included five *Gekko japonicus* (one publication), one *Eumeces japonicus* and five *Takydromus tachydromoides*. One *Elaphe climacophora* was also collected but released. This brief American literature history and record of my field observation pertains to the lacertid lizard *Takydromus tachydromoides*.

American literature history

Takydromus tachydromoides (common Japanese name

Kanahebi or “Metal Snake”) is an extremely common lacertid lizard with its widespread geographic distribution only in Japan. They are found in all kinds of habitats: river banks, urban areas, and hillside paddies (Goris and Maeda, 2005). This lacertid has very large keeled external plates, especially on the head, oviparous reproduction and an extremely long tail. Very few Americans have published on this lacertid. Stejneger’s Monograph, *Herpetology of Japan and Adjacent Territory* (1907 [1996 SSAR reprint]), gives a very detailed anatomical and morphological description. Sam Telford, Jr., by far has the most publications with discussions of food habits / predatory nature (Jackson and Telford, 1975), population biology (Telford, 1997a), and its component symbiote community (Telford, 1997b), being the most important.

Collection note

A small series of individuals (N = 5) was collected near 1-13-10 Kugenmaigen, Fujisawa, in the early morning hours with

a cool temperature under a large piece of plywood in a vacant field. The largest (Figure 1) was ~65 mm snout–vent length. They were transported to Carbondale, Illinois, maintained in a standard aquarium, and fed small invertebrates until killed, fixed in 10% formalin, then preserved in 70% alcohol and deposited in the Southern Illinois University-Carbondale (SIUC) Fluid Vertebrate Collection.

Acknowledgments

For assistance in the field I thank Hiroko Ohtsu. I also thank the USFWS (especially a herpetologist who inspected the 1977 imports and studied under Dr. James B. Murphy) for allowing me to legally import reptiles and amphibians from Japan. Scientific Illustration (SIU-Carbondale) made the print.

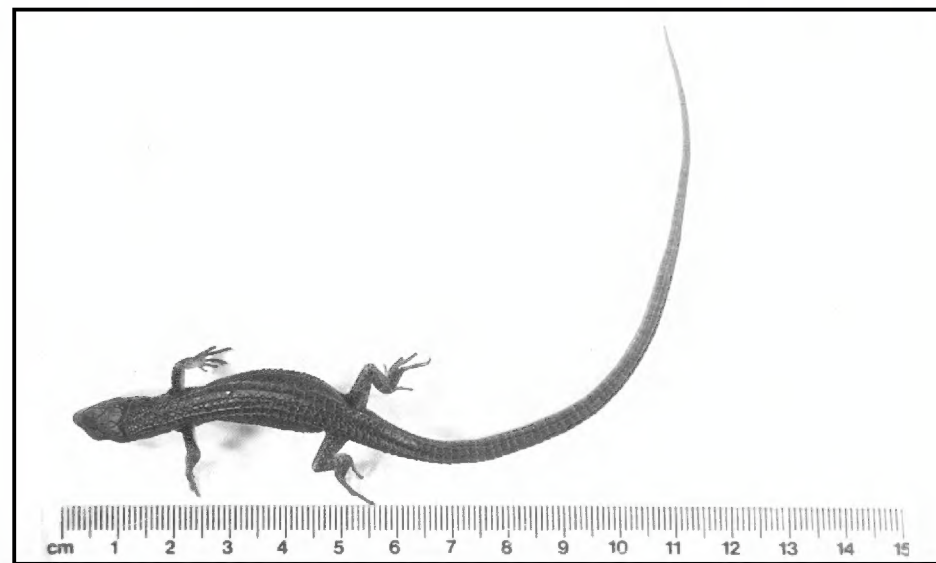


Figure 1. *Takydromus tachydromoides* (~65 mm SVL) from 1-13-10 Fujisawa Kanagawa, Japan.

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Additional Notes on Mudpuppy (*Necturus maculosus*) Habitats in Northeastern Wisconsin

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Introduction

Recently, I discussed museum vouchers and published records documenting the Wisconsin distribution of mudpuppies (*Necturus maculosus*) and presented additional observations, based largely on Wisconsin Department of Natural Resources (DNR) fisheries management activities, that confirmed and supplemented previous reports (Watermolen, 2015, 2018b). This included information for counties from which mudpuppies had not been documented previously. Examination of historical newspaper accounts has also contributed to a more nuanced understanding of this species' distribution throughout Wisconsin (Watermolen, 2020). Although the mudpuppy's occurrence has been documented in most counties with voucher specimens or photographs, the small number of records available from northeastern Wisconsin has limited our knowledge of the species in this region. Reports from inland lakes have been particularly sparse. Ongoing fisheries investigations, however, have resulted in additional encounters with this species. Following my suggestion that natural resources agencies benefit from

making unpublished data more widely available for conservation purposes (Watermolen, 2015), I here summarize additional data regarding this species' presence in northeastern Wisconsin.

County Records

Waterbody characteristics discussed in the following accounts are derived from Watermolen (1993), Bougie et al. (1996), and Wisconsin DNR (1995, 2020), as well as unpublished field observations.

Marinette County – Additional waterbody record – Watermolen (2018b) overviewed the available records of mudpuppies from Marinette County including the report by Caroffino et al. (2010) of mudpuppies in the lower Peshtigo River below the Peshtigo dam and several museum vouchers collected considerably upstream in the river system. Not surprisingly, mudpuppies also occur in the 232-acre impoundment above the Peshtigo dam. Wisconsin DNR fisheries biologists captured one in a fyke net on 5 April 2019 while working on the Peshtigo Flowage (45.05°N, 87.75°W). Benthic habitat in the flowage is 60%



Figure 1. With a maximum depth of 12 feet, Swamsauger Lake in Oneida County is one of the shallowest Wisconsin lakes from which mudpuppies have been reported. Photo courtesy of the town of Minocqua.

sand, 20% muck, 15% gravel, and 5% rock. Observations made while snorkeling in the flowage suggest relatively large, flat, partially embedded rocks provide suitable cover for reproducing mudpuppies (pers. obs.).

Menominee County – New county record – Mudpuppies have not previously been recorded from Menominee County, but would be expected here as they occur in all surrounding counties (Watermolen, 2015). Between 18 April and 23 April 2019, Wisconsin DNR fisheries biologists captured 96 mudpuppies in fyke nets placed in Legend Lake (44.89°N, 88.63°W), a 1,304-acre system of interconnected lakes and their surrounding wetlands with a maximum depth of 74 ft. Much of Legend Lake's in-water habitat is dominated by a diverse macrophyte community composed of *Chara* sp., *Najas flexilis*, *Ceratophyllum demersum*, *Vallisneria americana*, *Potamogeton* spp., *Utricularia* spp., and numerous other species. Extensive management efforts have been undertaken to control non-native *Myriophyllum spicatum*, which was first found in Legend Lake in the early 2000s, and to maintain the native plant community. Further efforts should be made to obtain mudpuppy voucher specimens or photographs from this county.

Oconto County – Additional waterbody record – I recently documented the presence of mudpuppies in Oconto County with vouchers from Leigh Flowage in the Little Peshtigo River watershed (Watermolen, 2018a). Wisconsin DNR fisheries biologists have since captured additional mudpuppies in Oconto Falls Pond (44.88°N, 88.17°W) to the southeast in the Lower Oconto River watershed. Mudpuppies were captured in fyke nets on 29 April, 1 May and 4 May 2019. The three specimens measured 305, 310 and 320 mm in total length. Oconto Falls Pond is a 167-acre impoundment with a maximum depth of 28 ft. The lake bottom is made up of 60% sand, 35% muck, and 5% gravel. The lake has sparse macrophyte growth comprising primarily *V. americana*, *C. demersum* and native *Potamogeton* spp., with recent introductions of non-native *M. spicatum* and *Potamogeton crispus*. Rocky cover objects appear to be largely absent from the lower stretches of the flowage, but the upriver portions of the lake have abundant coarse woody debris and fallen trees that provide fish (and mudpuppy?) habitat (pers. obs.). Mudpuppies are now reported from all major tributaries to Upper Green Bay.



Figure 2. Gravel and cobble habitat on the bottom of Plum Lake, Vilas County, Wisconsin. Photo courtesy of the Wisconsin DNR.

Oneida County – Additional waterbody and shallow lake records – In addition to the five waterbodies documented previously in Oneida County (Watermolen, 2018), fisheries managers captured mudpuppies in fyke nets in North Nokomis Lake (45.85°N, 89.45°W; 470 acres, max depth = 73 ft) on 12 May 2018 and 14 May 2019, Swamsauger Lake (45.79°N, 89.96°W; 136 acres, max depth = 12 ft) on 29 April 2019, and Two Sisters Lake (45.77°N, 89.53°W; 719 acres, max depth = 63 ft) on 21 May 2018 and 18 May 2019. These lakes have predominantly sand bottoms (45–85%), with relatively little gravel (5–25%) or rocks (0–15%). Swamsauger Lake (Figure 1), a seepage lake, is the shallowest Wisconsin lake from which mudpuppies have been reported (unpubl. data).

Vilas County – Additional waterbody records – Vogt (1981) recorded mudpuppies from four locations in Vilas County. A voucher specimen collected in Plum Lake (46.00°N, 89.52°W; 1,057 acres, max depth = 57 ft) in August 1937 is available at the Chicago Academy of Sciences (NWU-1111). More recently, Wisconsin DNR fisheries biologists netted mudpuppies in Plum Lake on 19 April 2015 and Trout Lake (46.04°N, 89.67°W; 3,864 acres, max depth = 117 ft) on 1 May and 4 May 2016. The Wisconsin DNR's chief of fisheries research also reported capturing several mudpuppies in Sparkling Lake (46.01°N, 89.70°W; 157 acres, max depth = 60 ft) in March 2015 (Greg Sass, Wisconsin DNR, pers. comm.). Finally, a mudpuppy was captured by fisheries biologists working in Little Star Lake (46.11°N, 89.86°W; 260 acres, max depth = 67 ft) on 3 May 2019. The bottoms of these four lakes are mostly sand (30–60%), gravel (10–40%), and rock (10–25%), with relatively little muck (0–10%). Plum Lake is the exception with about 30% of its bottom covered in muck but it also has areas of larger rocky cobble that appear to be likely habitat for mudpuppies (Figure 2).

Waupaca County – Continued persistence – Vogt's (1981) map includes two collection locations in southwestern Waupaca County, but I have been unable to track down voucher specimens from this area. Nonetheless, recent work confirms the continued presence of mudpuppies in the Tomorrow-Waupaca River watershed. Between 17 April 2019 and 23 April 2019, fisheries biologists captured 21 mudpuppies in fyke nets deployed in the Chain O' Lakes, a series of 22 interconnected lakes that are fed by springs and Emmons and Hartman creeks. These lakes support one of the most diverse fish communities

found in the region, with representatives from warmwater, coolwater, and coldwater assemblages. The lakes are very deep relative to their surface area and have narrow littoral zones. However, the deeper benthic habitat provides ample protective cover for mudpuppies (pers. obs.). Mudpuppies have also been encountered in the Wolf River in the southeastern part of Waupaca County (Anonymous, 1964; Jeff Zinuticz, Wisconsin DNR, pers. comm.).

Discussion and Conclusions

When considered alongside museum specimens and published records, field data collected by trained biologists provide a more complete picture of the occurrence and status of this species and provide additional insights into its habitat use.

Although long known from some of the region's larger rivers and flowages, the mudpuppy's occurrence in inland lakes has been less well documented. With some notable exceptions, lakes in the region where mudpuppies have been encountered tend to be large (> 100 acres), deep (max depth > 50 ft; thermally stratified), drainage lakes with substrates comprised primarily of sand and gravel with some rocky areas. These lakes often have diverse plant communities in their littoral zones and boulders or other rubble that provides shelter for mudpuppies in their deeper zones. Given the large number of lakes in the region (e.g., 1,095 and 1,147 in Oneida and Vilas counties, respectively), it is quite likely that mudpuppies occur in many additional northeastern Wisconsin localities. Fisheries managers should continue recording their mudpuppy captures and efforts should be made to obtain additional vouchers from across these counties.

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**Notes on the Tiger Rattlesnake (*Crotalus tigris*) in the Vicinity of Tucson, Arizona:
Comparative Frequency of Encounters; Definitions of Some Terms Pertaining to Reproduction;
and Some Pictorial Looks at Pregnancies and Parturition**

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I have mentioned over and over in these columns that ever since July 1989, I have been dutifully recording every snake that I have found in Arizona. I have been doing that with tortoises and Gila Monsters as well—not to mention many other herp species that do not neatly fit into this particular column. Initially my main purpose for written documentation was to ascertain the best time to seek, and especially find, the local herps. In other words, it was merely a herp-hunter’s tool that led to understanding when I should go out, and when I should stay home. I used three basic methods to find herps. These methods were, in order of preference, hiking (day or night), road cruising (day or night), and turning cover objects (mainly by day). There was never any competitive reason for all this documenting. *Never* was this done in the spirit of “I can find more snakes than you,” although some herpers took it that way. But gathering data is one thing, and assembling it all into something cohesive is quite another. I have been gathering data for nearly 31½ years, but have assembled only some of that data (23½ years’ worth). In short, I am seven years short. Instead of having one great, almighty, all-powerful spreadsheet containing the most staggering herpetological dataset ever seen by mankind for the Tucson region for over 30 years, I can *only* show you results based on 23½ of those years. Whenever the remaining seven years (eight years when 2020 is finished—good riddance!) are finally added in, the only thing that will change is that there will be *more of the same*. The ratios will not change much. The purpose for creating Table 1 is simply to demonstrate that of seven species of cool herps found near Tucson, the Tiger Rattlesnake (*Crotalus tigris*) is the rarest. We *could* use a word or combination of words to replace “rare” if the reader is uncomfortable with the word. But we’re not going to do that. We’re going to *pound it*. What I hope to show with Table 1 is not only how rare Tiger Rattlesnakes are, but that they are rarer by huge margins, and the rarest of the five species of rattlesnake found in and around the perimeter of the Tucson Valley. The Tiger Rattlesnake: rare, rarer and rarest of them all!

Table 1. Numbers of individuals encountered for seven species of herps found near Tucson, Arizona, by the author and his field companions. The results reflect 3,430 field trips conducted during the years 1989–1995 and 2000–2016.

Species	N
Western Diamond-backed Rattlesnake (<i>Crotalus atrox</i>)	2560
Sonoran Desert Tortoise (<i>Gopherus morafkai</i>)	1154
Sidewinder (<i>Crotalus cerastes</i>)	623
Gila Monster (<i>Heloderma suspectum</i>)	389
Mohave Rattlesnake (<i>Crotalus scutulatus</i>)	318
Black-tailed Rattlesnake (<i>Crotalus molossus</i>)	297
Tiger Rattlesnake (<i>Crotalus tigris</i>)	193

Before diving into this table too deeply, the undisguised smartass inside me feels compelled to nick Carl Kauffeld just a little bit. I know that many of our stalwart CHS members swear *by* him, while I mostly swear *at* him. I do want to have a little fun with him by quoting what he had to say about the Mohave Rattlesnake in Arizona: “It is safe to say that this rattlesnake is by far the commonest of any in southeastern Arizona. They are not only the most abundant of the rattlesnakes, but they are one of the most frequently encountered of all snakes.” (Kauffeld, 1957, page 142.) Yeah—right! I think it is safe to say that *that* statement was *not* safe to say. But I also say many things that are not safe to say, so who am I to pick on the poor guy? (Yup! Your author picks on dead people. What a stud!)

Moving on to Table 1, the number of species listed was deliberately limited to the five types of rattlesnakes that occupy the turf that I have historically visited the most. The numbers of tortoises and Gila Monsters were added to this table, as they occupy the same happy herping grounds as the others, and are considered to have a certain universal “cool factor” with herpetologists both in and out of Arizona. At first glance, the reader might think the numbers on this table are greatly exaggerated. Especially considering that these numbers do not represent sightings, but individual herps. Were I discussing sightings—which I hope to do some day—the numbers on five of the seven species would skyrocket tenfold or more. (Only the Sidewinder and Mohave Rattlesnake numbers will remain largely unchanged.) Every honest effort was made not to count the same animal twice. But if one were to consider that each outing averaged over five hours, and more times than not, somebody else was grinding with me for those same five hours, some simple math would reflect that I’m not really bragging, I’m complaining! There is still much work to be done with my raw data. (What an understatement!) But for this column, I hope that I have proven how comparatively rare the Tiger Rattlesnake is on my turf. The fact that I have seen more than twice as many Gila Monsters as tigers speaks volumes for the point that I am trying to make. To further emphasize (or beat to death) that point, a rough estimate of how much field time was involved in simply finding a tiger is in order. Assuming five hours and two herpers per field trip, what this table and its caption are saying is that we find one tiger per every 178 hours of field effort. That’s pretty dismal! Hence, to me personally, the simple act of finding one is a great achievement. To be able to go beyond merely finding one to possessing the ability to discuss pairings, mating, parturition and many other aspects of wild Tiger Rattlesnakes is something that before 2006, I never *dreamed* could happen to me. Thanks to radio-telemetry, and an excellent core group, I was able to live the tiger dream for ten years. There are only two groups of people on this planet who can relay the sort of information on

tigers that is about to be revealed in this column. One such group is Matt Goode and his associates, and the other is the Suizo Mountain Study and its associates. When Matt wrote the chapter on Tiger Rattlesnakes for *Rattlesnakes of Arizona* (Goode et al., 2016), the effort was the culmination of 14 years of radio-tracking, mark and recapture genetic studies in several mountain ranges that surround Tucson, as well as an extensive effort to collect and preserve every shred of historical literature that exists on them. Thanks to Marty Feldner, a trickle of reproductive information from the Suizo Mountain Study was included in Dr. Goode's chapter. At the time his masterful work was being prepared, I was personally so overwhelmed by so many aspects of herpetology that I barely had the time to read the draft (which was *excellent*). Matt later told me: "I added your name as a coauthor because I *wanted it there*." How I *wish* that I had been able to find the time to be worthy of the honor that Matt bestowed on me. So does he!

Two weeks have passed since the last sentence in the previous paragraph was written. What I did during that time period was start sifting through our data binders and images with the intent to mine the reproductive data of every female tiger under our watch. The effort was performed with the hope that I could find and recount them all for inclusion in this particular column. To make a long story short, I didn't achieve that goal. I will continue the effort in the months ahead, and report the final verdict once I know what that is. On the positive side, I have thus far determined that the female tigers of the Suizo Mountain Study gave birth seven times over the ten-year period that they were under watch. I *think* there were more than those, but the going will get tough with the remainder. Tiger Rattlesnakes are not only rare, they are secretive. We are going to shift gears a bit here, but will revisit the subject of some on-the-ground pregnancies with Tiger Rattlesnakes toward the end of this piece.

As none of you will remember, in last month's column, I discussed two Tiger Rattlesnakes that gave birth (Repp, 2020). I also said this: "I am finally wrapping my brain around such terms as spermiogenesis, follicles, ovaries, oviducts, vitellogenesis and ovulation, to name a few." While I still have a long way to go with completely knowing and understanding these and other terms, I want to try to explain them anyway—*before* I forget that which I have so recently learned. My original thought was to simply spew out all the accepted terms that brainiac biologists use on a daily basis. Dr. Emily Taylor provides an excellent treatise on the subject in *Rattlesnakes of Arizona* (Taylor and Booth, 2016). But the terms used in that effort are *not* reduced to the simplest grammatical denominator. Personally, I have been hearing and reading such terms as *follicles* and *vitellogenesis* for over 25 years without knowing exactly what they mean. It was easy for me to just fall silent and build a wall of ignorant complacency around myself. Was it Lincoln who once said "It is better to remain silent and thought a fool, than to open one's mouth and remove all doubt"? Just recently, I finally opened my mouth, and started asking questions. I did so mainly for selfish reasons—I *really* want to know this stuff. That is the humble side of me talking. The underlying arrogant side of me was operating under the notion that if I could understand it, I know that I can explain it so that anybody who reads this column will also understand it. We will find out if that's true very

soon, starting with the next paragraph of this column!

(Tiger) Rattlesnake Reproductive Biology 101

Before proceeding, it is important to note that we speak only of rattlesnake reproduction generally, and Tiger Rattlesnakes specifically, in this column. And we are focused only on the five species of rattlesnake that are mentioned in Table 1 with all that follows. Now would be the proper time to acknowledge the five people who have gotten me this far with my basic understanding of rattlesnake reproduction. In chronological order, my teachers, have been Dr. Gordon Schuett, Dr. Matt Goode, Dr. Dale DeNardo, Dr. Stephen Goldberg and Dr. Stephen Barten. With a lineup like that, who needs college? All five of these fine folk have *willingly* and *happily* helped me down the road to a better understanding of the process. To a man, they are almost *begging me* to ask more questions! When speaking with the various experts mentioned above, the talk often drifted toward egg-laying species of snakes and lizards. To the exasperation of these fine folk, I nipped this kind of talk in the bud. No matter how similar the process may be, or how necessary knowledge of both processes may be, it is *not exactly* the same. The terms and timing change. For example, we can't really look at a Coachwhip (*Masticophis flagellum*) and say that the terms for the reproductive processes are universally the same for them as with rattlesnakes. And the timing of reproduction varies as well. Here in Arizona, Coachwhips almost universally mate in May. Sidewinders also mate in May here, but *none* of the other species of rattlesnakes found in Table 1 do so—at least not those under my watch. Getting a little ahead of ourselves, what an egg is called through the various stages of reproduction with a Coachwhip differs from what it is called with rattlesnakes.

Reproductive organs: Both male and female rattlesnakes have two of everything where reproductive organs are concerned. With the male, the dual tools are called hemipenes. They lie caudal to either side of the male's vent. When in use, one of them will evert inside out through the vent. Each hemipenis (hemipenis is the singular for the plural hemipenes) is connected to one of the male's two testes (singular testis) by a duct known as the ductus deferens (the plural is ductus deferentes). The female has two tubes called the oviducts that connect the ovaries to the cloaca. Every male rattlesnake has two hemipenes, two testes and two ductus deferentes. Every female has two oviducts and two ovaries.

Mating/copulation: Despite the fact that reproductively speaking, male rattlesnakes have two of everything organ-wise, they can only employ one at a time when in the act of mating. I have more than once had somebody tell me of seeing a male rattlesnake use both hemipenes during mating. (*That would be a stretch!*) The bifurcation, or fork, between the lobes of a hemipenis can lead to this sort of confusion. During the latter stages of copulation, which can last upwards of 24 hours, the bifurcation in the hemipenis enables sperm to be directed to each of the two oviducts in the female. The reader is encouraged to view Figure 1 for an image of a rattlesnake hemipenis, as well as an image of how it is actually used in copulation.

Mating season for Tiger Rattlesnakes: There have been two long-term radio-telemetry studies on Tiger Rattlesnakes

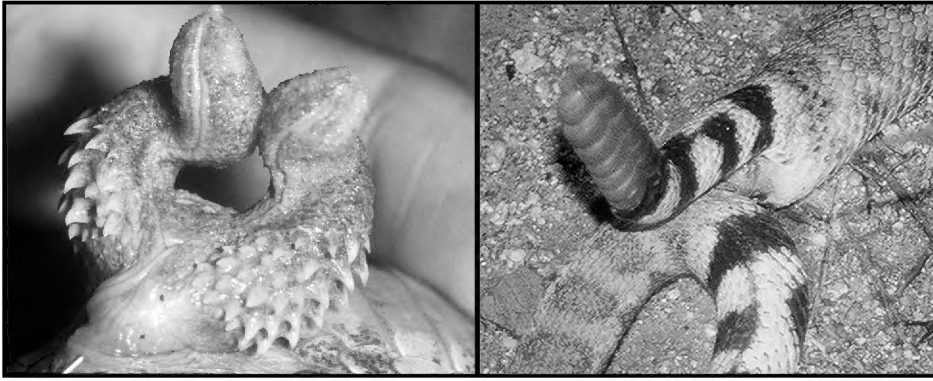


Figure 1. (Left) The hemipenis of a Western Diamond-backed Rattlesnake (*Crotalus atrox*). Along with the blood engorgement of the erect hemipenis, the spines assist the male in staying inside the female until the mating episode is complete. The bifurcation (fork) allows sperm to enter *both* of the oviducts during ejaculation and subsequent insemination. Image by David L. Hardy, Sr. (Right) Mating between a pair of *Crotalus atrox*. At this point, the female is actually crawling away from the male. She may be done—he isn't! Image by the author.

near Tucson. Neither study indicated any evidence of mating, or courtship, or even male and female pairings in the spring. To be sure, the Suizo study had a male and female *winter* pairing two times in consecutive years, but these broke up *before* the onset of spring (Goode et al., 2016; Repp, 2017). Lowe et al. (1986, pp. 49-50) make the following somewhat innocent claim regarding tigers: “Neither mating nor fighting has been observed in the natural habitat. Adult male and female pairs have been found together in southern Arizona in late May and mid-August.” It is unfortunate that no citation—not even in the form of a personal communication—follows that second statement. This “adult male and female pairs in late May” business has grown into the realm of accepted knowledge with the local academic crowd, and has even led to erroneous comparisons of the timing of tiger reproduction to that of whipsnakes and other egg-laying snakes in peer-reviewed papers. While this author is fond of the saying “absence of evidence does *not* necessarily indicate evidence of absence,” in this case, were sexual pairings between tigers the normal routine, *both* of the two studies in our area would have observed it—many times over. The personnel in *both* studies *tried very hard* to witness it, but alas, we could not see what was not there (see also Goode et al., 2016). One possible explanation for whatever was observed by Lowe or whatever invisible man or woman reported it to him is that Lowe or this unknown person saw two females together, and assumed that they were a sexual pair. The female tigers of the Suizo Mountain Study routinely paired in May—usually during spring ecdysis events (Schuett, Repp and Feldner, unpublished observations).

Terminology and timing of reproduction for male rattlesnakes: Mature male rattlesnakes produce sperm and are capable of storing it for future use. Here in the southwest, most mating events transpire in late summer or early fall. That is also the time when males are producing new sperm. With male rattlesnakes, sperm is stored in the epididymis, which is basically a network of tubes connected to the testis. Old sperm is eliminated passively as new sperm replaces it. Some of the local species of *Crotalus*, namely *atrox*, *scutulatus* and *cerastes*, also have an additional spring mating system. *Crotalus molossus* and *Crotalus tigris* do not seem to be mating in the spring—at least not commonly. Without going too deeply into the complexities of the male mating system, the whole process leading up to mating falls under the heading of spermatogenesis. The

spermatogenic cycle is divided into three phases. If we look specifically at Tiger Rattlesnakes per Dr. Goldberg’s 1999 work, and use the astronomical calendar that begins on 1 January, the phases of sperm production are called: (1) Regression: The testes are shrinking, and undergoing a little quiet time. But there is ample sperm storage. This process would normally occur from January to April. (2) Recrudescence: Renewal of reproductive interest and readiness of the testes. Occurs just prior to spermiogenesis. It transpires from late April through June. (3) Spermiogenesis: Production of new sperm. As suggested above, the old sperm is eliminated passively as the new sperm replaces it. Spermiogenesis is occurring from July through October. From November to January (and beyond), the male reproductive cycle regresses back to quiet time (see Goldberg, 1999).

Terminology and timing of reproduction for female rattlesnakes: It is very difficult to know where to begin in terms of defining the sequence of the terms for reproduction with female rattlesnakes. We will start with the egg—even though with rattlesnakes, it is not called an egg at any point throughout the reproductive process. It is instead initially called a . . .

Follicle: Which is another word for immature egg—if we were discussing an egg-laying species. But since rattlesnakes are live-bearing, the term “egg” goes right out the window. (And if it doesn’t, it will be all over my face.) No, this was all explained to me proper, from many directions. (That doesn’t mean that I agree, it only means: Read my lips! “No! No! No!” No egg, *bad egg!* I will never use that *bad word* to describe a follicle again.) Every female rattlesnake is born with follicles. They reside in the ovaries, and start as dinky little things not visible to the naked eye. Most experts think that the number of follicles is set at birth—much like humans. Once a female matures and initiates reproductive cycles, as with humans, she starts to use up these follicles. In the event that a female rattlesnake uses them all (it is currently not known if this ever happens), she likely will not—*cannot*—make new ones. If a mature female rattlesnake has a good year or two, her body tells her it is time to reproduce. She begins to recruit follicles. Once recruited for a given reproductive cycle, a limited, set number of follicles will enter what is called the hydration phase. These follicles grow and gain fluid in preparation for the next phase of reproduction. The words “set, limited number of follicles” were used because the female, or rather, the physiological condition of the female, sets the number of follicles that are being prepared for the future birthing. Rattlesnakes are capital breeders, meaning that they only proceed with a reproductive cycle if they have sufficient energy stores to support the entire cycle all the way through birth. They do not count on acquiring more energy during the reproductive cycle. There is an old gambler’s term, also used often in business. That term is “betting on the come.” With the gambler, that could be betting heavily on the last unseen turn of a card. In business, it is a huge outlay of money with the hope that the investment pays off. By nature, the female Tiger Rattlesnake does not do this. She is a cautious thing. She only bets on the energetic resources that she has to carry the “set, limited number of follicles” thorough to parturition. The second-to-last image in this article shows a Tiger Rattlesnake with five neonates. She had five neonates because she had the stores of energy to allow for it. Hence, five of her follicles, and perhaps a few more,

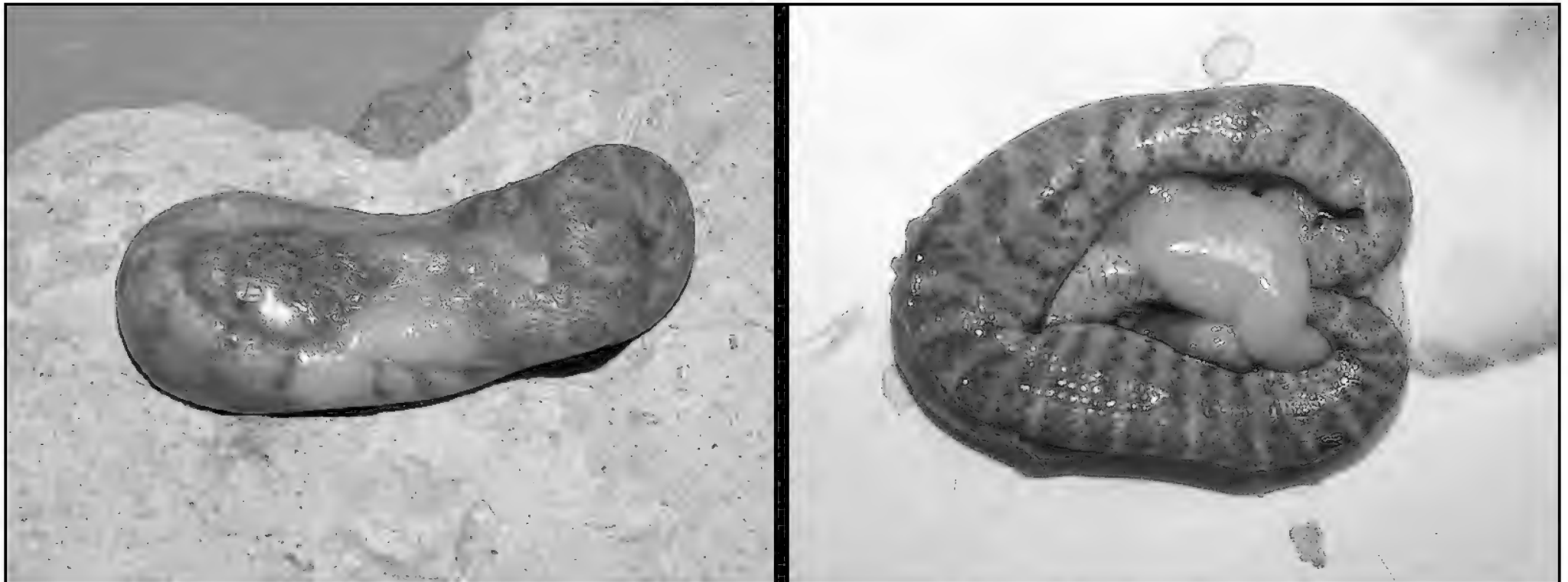


Figure 2. (Left) A stillborn Tiger Rattlesnake (*Crotalus tigris*). While distinctly egg-like in shape, the membrane that encapsulates the neonate is called the amniotic sac. (Right) The amniotic sac is dissected, revealing the yolk that feeds the wee ones while they are in the oviduct. Images by Martin J. Feldner.

began the hydration phase of development. And then those same five follicles entered the next phase, which is called vitellogenesis.

Now I've done it! Vitellogenesis? Never in my life have I ever been so terrified to write a paragraph. The whole damn article is done and ready to send *except* for an explanation of vitellogenesis. Maybe if I take bite-sized chunks, I'll get it? Let's try that! The word vitellogenesis is a combination of two words. The first is vitellin, which my dictionary defines as "the chief constituent protein of egg yolk." That same dictionary defines a synonym of genesis as being "beginning." "Protein beginning?" **Eye like it!** The same follicles that have gone through the hydration phase now begin to yolk up. We all know that the yolk of an egg contains protein. But when the follicle begins to yolk up, where does that yolk come from? In the case of a developing recruited hydrated follicle that resides in the ovary, the protein vitellin is produced in the liver, carried through the bloodstream into the ovary, and deposited into the follicle. Some might say that rattlesnake reproduction actually begins in the liver. I'm going to blame the ovary, as it is the organ that has it last. As soon as this "protein beginning" starts within the follicle, the process is called vitellogenesis. When vitellogenesis first begins, the yolked follicle of a Tiger Rattlesnake might be 6 millimeters long. The follicle begins to grow in the ovary until it is roughly 20 millimeters long. Vitellogenesis ends when yolk deposition is deemed complete, and our mamma rattlesnake ovulates. Nothing to it! (This stuff is easy. I think I'm ready to tackle genomes and mitochondrial DNA next!)

Ovulation: Simply put, the follicle leaves the ovary and is collected up by the oviduct.

Oviduct: This is the tube that connects the ovary to the cloaca, and is where fertilization and embryonic development occurs. The oviducts have tiny compartments along their inner walls that retain sperm from previous mating(s). These compartments may as yet not be assigned a formal name. The word "crypts" was passed my way—with some uncertainty. That's kind of negative! Another name passed down the pipe to me was "sperm receptacles." That is *not* very imaginative at all. Hell! I can do better than these! How about "sperm guzzlers?" Anyway,

the most acceptable term for follicle at this point is ovulated ovum. Within 24 hours of ovulation, the retained sperm fertilize the ovulated ova, which then—just like with people—become embryos. The embryos will spend months in the oviduct, consuming yolk to develop and grow. When fully developed, the embryo passes through the cloaca and out the vent. There are often extra embryonic membranes and reproductive fluids that accompany the neonate at birth. But as about to be explained, the membrane that usually surrounds the neonatal rattlesnake is called the amniotic sac.

Amniotic sac? That's a good one! Were our pregnant female rattlesnake a whipsnake, kingsnake or any other egg-laying species of snake, what passes through the cloaca and out the vent would be called an egg. We all know what an egg looks like. Since we *don't* all know what an amniotic sac looks like, I ask the reader to refer to Figure 2. Almost as soon as the healthy neonate (baby snake) is spewed out through the vent, it will break out of the amniotic sac, and draw its first breath. Sometimes the neonate breaks out of its amniotic sac during the birthing process, while it is still in the oviduct. Those have yet to be given a proper name. Perhaps "amniotic sac-less" neonates? Gel babies? Finally, we get to . . .

Parturition: Birthing. I guess we just got ahead of ourselves with the description above. Anyway, no eggs involved. Just amniotic sacs and gel baby rattlesnakes. And if you want more, go ask your mother, child!

In all fairness to the experts who helped me to define the process, it should be known that each fed me pieces of information, mostly unaware that others were involved. Had I gone to all five of these people at once in a mass email, everything would have fallen apart before I got this far. There would have been hesitation—each waiting for the other to respond. Whoever would have responded first would have been, politely or otherwise, pounced upon, and the whole discussion would have disintegrated into a melee of conflicting terms and their meanings. The fact is that some of the terms have yet to be named in a manner universally accepted by these and other rattlesnake gurus. It is better that I allow all five to take credit for whatever

I got right, and assume responsibility for that which they or others may deem incorrect. Should you be *that person* who is jumping up and down whilst wetting both pantlegs with righteous rebuttals or additional information, I would welcome you to submit your statements to our editor. He will be more than happy to publish your words, and I would also welcome anything *correct* that you have to add. If any or all of this stuff is new to you, and you want to dig deeper, I encourage you refer to the reproduction chapter (Taylor and Booth, 2016) that can be found in Volume 2 of *Rattlesnakes of Arizona*.

Before you put yourself through that, I firmly believe that a simpler explanation of this very complex process does not exist anywhere in print. If you read, understand, and retain this much, you will at least comprehend the basics of the terms with any future conversation with the experts. And also, you will get the gist of anything that you see in writing.

The criteria the author used in determining pregnancy with (Tiger) Rattlesnakes under observation

Earlier in this piece, I stated that as of this date (2 September 2020), I have determined seven pregnancies and subsequent parturition events with the Tiger Rattlesnakes of the Suizo Mountain Study. Surely more will be found before the effort at a final tally is deemed complete. (I was hot on number 8 when a deadline forced me to surrender.) The reason that the effort to arrive at a final answer is so time-consuming centers mainly on the general protocol of the study. We would only physically touch and process our snakes once a year. That once a year was when we would capture or recapture a tiger for reasons of surgically implanting a transmitter. Once that transmitter was installed and the subject was released, we were normally limited to what we could see of the snake with zero-to-minimal disturbance. By utilizing this method, we got as close to a pure, hands-off natural history study as one can get. I will say right off that regardless of this approach, four of the seven parturitions mentioned occurred with tigers that were brought into the lab. How I wish that we had brought them *all* into the lab now, as this allows for solid conclusions to be drawn without any questioning of our methods. However, the remaining three lady tigers taught us *priceless* on-the-ground lessons that would otherwise not have been possible.

There are two *huge* factors in determining whether or not the information that was interpreted with the on-the-ground tigers can be accepted as scientific fact. The first of these factors is one that successful herpetoculturists will embrace. They recognize “the look” of a pregnant (live bearing) or gravid (egg-laying) snake. Understanding “the look” of a snake that will give birth at some point in the future may *never* be accepted by science. Be that as it may, our three on-the-ground females *all* displayed what we call “the look.” Simply put, “the look” is the rear 30% of the snake appearing to be stuffed with a sausage. It has the appearance of an elongate food bolus, that in obvious cases, extends to the cranial edge of the vent. There were several people involved with the Suizo Mountain Study who know “the look” well. The three people who did the most tracking of the tigers were Marty Feldner, John Slone, and me. And while I’m talking about these folks, let me say with all certainty that there

are no people alive who are more dedicated, more motivated, and more driven by the fire of pure *enthusiasm* than we were with this study. And yes, we know “the look.” And tigers gave us that “stuffed sausage” appearance early during their reproductive cycle. By early in their reproductive cycles, I mean with a high degree of accuracy we knew *before* they went into hibernation that they would give birth the following summer. We can’t make the same claim with the *Crotalus atrox* and *Crotalus molossus* under watch.

But as stated, I don’t expect science to accept our notion of “the look” to be accepted as proof of pregnancy. Radio-telemetry provided year-round observations with the tigers under watch, and certain *consistent* variables led to the final “yes or no” verdicts with the pregnancy questions I was asking of myself. In short, I created a list of the variables required to go beyond merely “the look” of pregnancy with each of the female tigers that I am claiming had a parturition event. With the benefit of experience, I was able to establish criteria: seven different factors that all pointed to a parturition event occurring. Not all seven factors are required for proof, but the more “yes” answers piled on for each event, the more solid the answer to any pregnancy questions that I asked of myself. For each numbered point, further explanation is provided in italics inside parentheses.

1. The female is observed in a pairing, courtship or (preferably) mating event during the late summer prior to her birthing year. (*A yes answer here is nice, but not as important as one might think. A witnessed mating event may not result in the male involved being the father of any of the progeny produced the following summer. The ability of a female rattlesnake to store and use sperm from previous copulations complicates things.*)
2. In the late summer or early fall of the year before parturition, the female is observed growing exceptionally hefty toward the rear. (*As stated above, a successful pregnancy relies on stores of energies being available in order to trigger vitellogenesis, and eventually, ovulation. When looking at a Tiger Rattlesnake from the outside, without benefit of ultrasound, the female will look distally plump. A “yes” answer here was huge in my final determination of a parturition event the following year.*)
3. The female tiger either left her hibernaculum (egress) by end of March in the year of her parturition event, or was viewed out basking during calendar winter (Figure 3). (*We have just skipped fall ingress into their hibernaculum, as well as overwintering. Ingress is universally the third week of October, and egress varies according to reproductive condition. During their non-reproductive years, the female tigers did not start their active seasons until late April at earliest.*)
4. A pregnant tiger makes only minor movements from spring egress until parturition. (They did not move off the hill during the active season until *after* they gave birth). (*Our study was centered on a small outlier hill named “Iron Mine Hill.” The hill is roughly 60 meters tall by 300 meters wide [east-west] by 500 meters long [north-south]. All the tigers that gave birth stayed within the top 30% of the hill, which confined their home range from hibernaculum to parturition site to (at most) 90 meters by 150 meters. Most pregnant tigers*



Figure 3. Female *Crotalus tigris* number 6, Ct6, AKA “Gracie,” viewed basking outside her hibernaculum on 15 January 2011. The author has spent a prodigious amount of time in the field during winter, and has only observed basking female tigers a total of six times in the process. (Once in January [shown], twice in February, and three times in March.) In all cases, the females were distally plump, and this may point to the early stages of pregnancy. We are one long-term study away from learning this and many other interesting, if not revolutionary, aspects of reproduction with *Crotalus tigris*. Image by the author.

moved far less than that. Any tiger that ventured completely off the hill between egress and late June proved to be having an off-cycle year. This behavior was consistent, and a strong indicator of pregnancy. I’m sure there is a paper in that. I hope somebody else will write one someday.)

5. By late June, the pregnant tiger is viewed fat just prior to entering a presumed nesting site, and thin as soon as she leaves it. *(This was somewhat frustrating during the ongoing search, but is a very strong indicator of a parturition event. Thus far in the information gathering process, there has only been one instance of this, which is illustrated below.)*
6. There is a neonate or the shed skin of a neonate observed at the presumed nest site. *(This is another very important “yes” to have. There are only two instances of this happening, and these will be shown at the end of this piece.)*
7. The pregnant tiger gives birth in the lab. *(A “no-doubter.” A “yes” answer to this negates all necessity for points 1-6!)*

Should the reader be confused by any of this, some images will appear at the end of this article that show the situations with three tiger pregnancies that do *not* have the answer “yes” to point 7 above. In the end, the reader can look at these and decide “pregnant or not” as they see fit. I am saying “pregnant” to these three, or we would not be doing this. No matter what, I ain’t getting paid by the pregnancy here.

A pictorial look at the pregnancy and parturition of Ellie

We will bring the seven-point criteria above alive with the twelfth tiger to enter our study. Marty Feldner found *Crotalus tigris* number 12, or Ct12 for short, on the evening of 7 June 2012. We were delighted to note that Ct12 was a female, and eventually named her Ellie, after Marty’s mother. Ellie was a true gift to us in that we managed to capture her just before she began to show signs of a future pregnancy. The very nature of her capture date forced us to do an implant surgery very close to the normal time that parturition in the species occurs. Her first full year came and went, and we were sweating losing her. From

her surgery due date of 7 June 2013, to 6 July 2013, we grew ever more frantic to recapture her, as we knew her transmitter battery was functioning on borrowed time. But she remained stubbornly buried out of sight until the evening of 6 July, when the first rain of the monsoon season brought her above ground for a drink. Marty had hill duty that night, captured her, and took her to the lab. She gave birth while in Marty’s hands, and became a “yes” to point 7 in the list above. Since we have so many images of her early phases of pregnancy, she is the ideal tiger to bring the seven point list above to life. Without further ado, let’s do that with Ellie:

1. The female is observed in a pairing, courtship or (preferably) mating event the late summer prior to her birthing year. **(Yes. See Figure 4.)**
2. The year before parturition, in late summer/early fall, the female is observed growing exceptionally hefty toward the rear. **(Yes. See Figure 5.)**
3. The female tiger left her hibernaculum (egress) by end of March in the year of her parturition event. **(Yes. She was viewed outside her hibernaculum on 17 March 2013.)**
4. A pregnant tiger makes only minor movements from egress until parturition. (They did not move off the hill during the active season until *after* they gave birth). **(Ellie moved a total of 130 meters southwest from egress, 17 March 2013, to her capture point on 6 July 2013. No, she did not move off the hill, and remained near the top of it for that entire time period.)**
5. By late June, the pregnant tiger is viewed fat just prior to entering a presumed nesting site, and thin as soon as she leaves it. **(Not applicable with Ellie. Incredibly, we did not get a single revealing image of her from 17 March 2013 until she gave birth on 10 July 2013. For that entire time period, she was either viewed under conditions impossible to photograph, or was buried out of sight.)**
6. There is a neonate or the shed skin of a neonate observed at the presumed nest site. **(Not applicable—neonates and their shed skins happened in the lab.)**
7. The pregnant tiger gives birth in the lab. **(Yes! See Figure 6.)**



Figure 4. Ct12, Ellie, in courtship with unknown male. The male is on top, and the rattles protruding belong to Ellie. Image by Martin J. Feldner, 26 August 2012.

Further discussion, a hypothesis and future directions

As indicated in last month's column, Tiger Rattlesnakes of the Suizo Mountain Study consistently gave birth one to two months ahead of the *Crotalus atrox* and *Crotalus molossus* (Schuett et al., 2016; Goode et al., 2016; Repp, 2020). Exactly how they accomplish this has yet to be defined, but tigers are one properly-equipped-and-funded project away from learning. The signs of the reproductive process with tigers appear to be accelerated early on. As some of the images below demonstrate, we saw "the look" of pregnancy with some of our tigers as early as September. Simply put, my wimpy, multiple-choice hypothesis is that they are entering hibernation in some form of either

advanced vitellogenesis, ovulation, or maybe even pregnant. This has yet to be proven, and is not "safe to say"—not even in the form of an educated guess. If I am correct, the knowledge gained would revolutionize the current paradigm that rattlesnake aficionados of the southwestern United States operate under, namely that ovulation and subsequent pregnancy occur post-hibernation. The portable ultrasounds of today are much improved, and in the proper hands, could prove me right or wrong with any future field study on Tiger Rattlesnakes. The question is well within our grasp to answer. Will any such study ever happen? I hope so! This here is Roger Repp, signing off from Southern Arizona, where the turtles are strong, the snakes are handsome, and the lizards are all above average.

A pictorial look at Kim, Gracie, Ellie, and two bonus lab birthings (Photographs by the author unless otherwise indicated)



Figure 5. Ct12, Ellie, summer and early fall 2012: (Left) Ellie on the crawl, 30 June, and (center) 22 July. Note the increase in volume toward the rear. In both of these images, she is out on the *bajada*, as far from Iron Mine Hill ("the hill") as she can get. (Right) Image by Martin J. Feldner, 29 September. Note the distal plumpness of her rear flank. At this point, she is on the hill, a scant 70 meters from her hibernaculum, which she entered on 20 October.

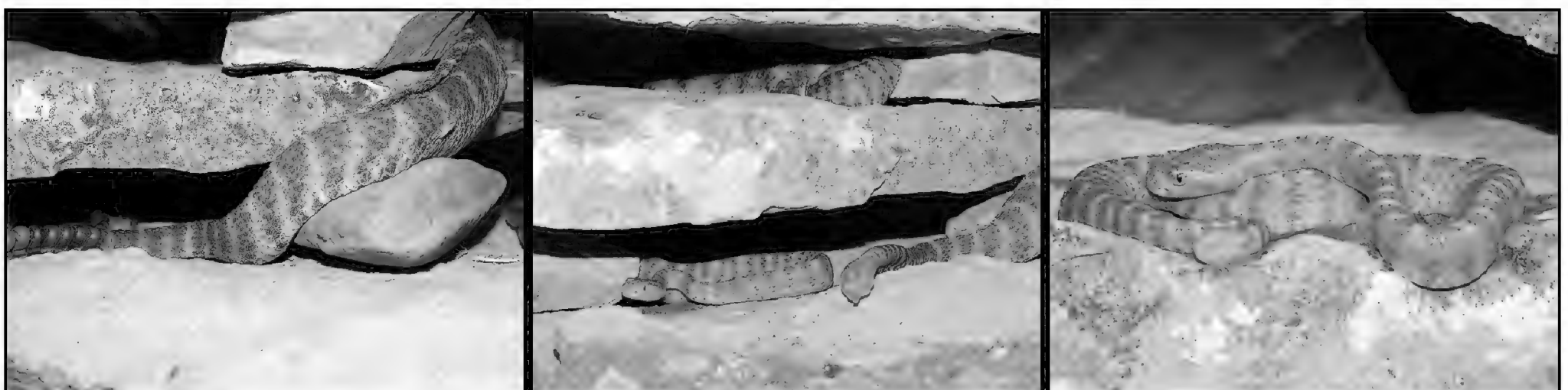


Figure 6. Ellie's parturition, 10 July 2013: (Left) Giving birth can take a lot out of a girl! (Center) Ellie and some of her neonates. She birthed a total of five healthy neonates, and the stillborn shown in Figure 2. (Right) One of the neonates from Ellie's litter—fresh out of the cloaca. All images in this set by Martin J. Feldner, 10 July 2013.



Figure 7. Ct1, Kim's parturition, ~3 July 2009: (Left) Kim's plump rear flanks as they appeared on 4 April 2009. (Center) Yes, giving birth can take a lot out of a girl! Compare with Figure 6 above. Image taken 11 July 2009. (Right) The only evidence that we had of Kim's parturition event was this lone shed skin of a neonatal tiger. Kim spent all of June in a series of boulders and crevices behind the hackberry bush stalks in this image.



Figure 8. Ct6, Gracie's parturition, ~17 July 2009: (Left) Gracie as she appeared on 11 July. (Center) By 17 July, she had moved into the stack of boulders pictured, and the author made three back-breaking visits, clambering about on all fours, trying to see anything resembling neonates or their shed skins. No chance! (Right) Gracie was still at her presumed nesting site the morning of 25 July, but she was observed crawling away from it that evening. In the end, all that we had to say about this pregnancy was: "goes in fat, comes out skinny."



Figure 9. Ct6, Gracie's second consecutive parturition, ~22 July 2010: (Left) Oh, how I wish we had employed ultrasound! Gracie as she appeared on 25 September 2009. As seen in this image, she has already put on an amazing amount of mass in two month's time. (Center) On the morning of 31 July 2010, the author tracked Gracie to the hole viewed in the top right corner of this image. She was not visible in this hole. The neonate viewed to the lower left immediately spooked and crawled into the hole to join her. (Right) The author visited the place with the neonate (Gracie's nest) again that evening. Gracie was viewed crawling out of that same hole. Note the slender flanks toward the rear.



Figure 10. Cuteness displayed in the lab, and two more parturition events: (Left) Marty's money shot of Ellie's birthing. Image taken 16 July 2013 by Martin J. Feldner. (Center) No name Ct23 and her five neonates, which she bore on 2 July 2014. (Right) Don't try this at home! This neonate, one of only two born to no name Ct22, was heavily sedated for this image. Ct22 gave birth on 27 June 2014, which is the earliest in the year that any published Tiger Rattlesnake parturition event has occurred. To give the reader a further size perspective, the longest loop of the snake is ~89 millimeters (3.5 inches) wide.

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Herpetology 2020

In this column the editorial staff presents short abstracts of herpetological articles we have found of interest. This is not an attempt to summarize all of the research papers being published; it is an attempt to increase the reader's awareness of what herpetologists have been doing and publishing. The editor assumes full responsibility for any errors or misleading statements.

ORIGINS OF CHAMELEONS IN SOUTHERN ITALY

R. Basso et al. [2019, *Herpetozoa* 32:11-19] note that the common chameleon, *Chamaeleo chamaeleon*, is a Mediterranean lizard that has been introduced in many islands, and its native origin in European countries is debated. Chameleons have been introduced in southern Italy, possibly from the Middle East and Tunisia. The authors conducted genetic analyses on mitochondrial DNA 16S gene on a large sample. They observed a multiple origin for the Salento (Apulia, southern Italy) population, with individuals phylogenetically related to populations of North Africa and two areas in the Middle East. Some individuals may have been released before the 1950s and some others in the 1980s, improving the establishment success of this species.

EYE-BULGING BEHAVIOR IN LIZARDS

M. A. Herrmann et al. [2020, *Copeia* 108(2):309-315] examined eye-bulging behavior in relation to scent-marking and chemosensory behavior in three species of iguanian lizards, *Sceloporus jarrovi*, *S. tristichus* and *S. virgatus*, in a controlled environment. They studied males of the three species and also females of *S. jarrovi* and *S. tristichus*. Overall, the frequency of eye-bulging was positively correlated to the frequency of chin wipes in males, but not females. Chin wipes rarely occurred in the absence of eye-bulging; they were closely associated with the latter and, to some degree, to other chemosensory behavior. Of the three species, *S. virgatus* exhibited the highest eye-bulging frequency. The possibility of eye-bulging behavior being utilized for chemical communication is discussed.

LIZARD POPULATION TRENDS OVER 14 YEARS

R. Meek [2020, *The Herpetological Journal* 30(1):20-26] notes that identifying population changes is a prerequisite for any conservation effort, but to evaluate trends requires long-term data sets. This paper describes changes in population numbers in two species of European lizards, *Lacerta bilineata* and *Podarcis muralis*, in a fragmented landscape in western France. Results are based on counts of mortalities and live lizard presence on roads collected over a 14-year period, which indicated wide annual fluctuations in numbers in both species, with interspecific annual trends strongly correlated. Snout-vent lengths in *L. bilineata* were generally greater when annual numbers were higher but not in *P. muralis*. Regression analysis of the logarithmic transforms of annual lizard numbers as dependent variables and year as the independent variable indicated that despite population fluctuations, numbers of both species were stable or increased during the period of observation. Jackknife analysis identified unusually high numbers of *L. bilineata* in 2012 and *P. muralis* in 2010, but data from these years had minimal influence on the general trends with the pseudo-regression coefficients generated from the jackknife analysis in agreement with the true regressions. The results were therefore congruent, indicating annual fluctuations in both species were underpinned by long-term population stability.

CONSERVATION OF THE COAHUILA BOX TURTLE

G. Castañeda Gaytan et al. [2020, *Chelonian Conservation and Biology* 19(1):14-21] note that the Coahuila box turtle (*Terrapene coahuila*) is an endangered species of chelonian endemic to the Cuatro Ciénegas valley in northern Mexico. It is the only aquatic member of the genus *Terrapene* and is dependent on permanent and seasonal wetlands. Over the past several decades, *T. coahuila* populations have declined from habitat loss as the wetlands have dried due to human modification of the valley. The authors conducted a survey of the status of the species from 2011 to 2018, updating previous estimates of population density and overall population size. They also collected data on sex ratio in each of the 8 wetland study areas in the valley and report a strongly male-biased sex ratio. The results indicate a total population size of approximately 1791 individuals, based on recorded densities from 0.24 to 3.3 individuals/ha among 539.76 ha of suitable habitat in the 8 wetland areas. This estimate is lower than previous studies indicated, implying direct effects of habitat loss on *T. coahuila*. If habitat loss due to lowering of the water table continues, this species will become extinct. The authors recommend conservation measures including upgrading the species' International Union for Conservation of Nature Red List status to Critically Endangered, protecting and restoring key wetlands in the valley, and establishing captive assurance colonies in Mexico.

THE GENUS *ERYX* IN IRAN AND ADJACENT AREAS

N. Eskandarzadeh et al. [2020, *The Herpetological Journal* 30(1):2-12] note that several attempts have recently been made to elucidate taxonomic status and phylogenetic relationships among the species and subspecies of sand boas of the genus *Eryx* throughout their distribution range, with no stable consensus about their taxonomy. Here the phylogenetic relationships among the populations of *Eryx* in Iran and adjacent areas are studied based on two mitochondrial markers (*cytb* and 16S). Sixteen morphological characters were examined for evaluation of morphological differences among major populations. Ecological niche modeling was applied to demonstrate the potential distribution of the populations in Iran. ENMtools was also used to measure the degree of niche overlap among the major populations in Iran. Based on phylogenetic reconstruction and considering the genetic distances with specimens from type localities, *E. tataricus* is a junior synonym of *E. miliaris* and the subspecies rank for *E. m. nogaiaorum* seems to be invalid. Considering the genetic distance of populations in western Iran and Iraq, and the habitat and morphological differences among the populations of *Eryx* in western Iran, Iraq and Egypt, the population of *Eryx* in western Iran is suggested as a different species from *E. jaculus*, named here as *Eryx* sp. and the ones from Iraq as *Eryx cf. jaculus*. Evaluation and revision of taxonomic status, distribution ranges and descriptions of morphological characters of the studied species are included.

MICROHABITAT USE BY HELLBENDERS

J. G. S. Neto et al. [2019, *Herpetologica* 75(1):21-29] note that hellbenders (*Cryptobranchus alleganiensis*) are long-lived, fully aquatic salamanders that inhabit cool, well-oxygenated streams and rivers in the eastern United States. Although once abundant, *C. alleganiensis* populations have experienced major declines across the historical range. Habitat degradation, siltation, aquatic contaminants, and infectious diseases are commonly suggested as contributors to these declines. Although Tennessee provides areas of high-quality habitat for *C. alleganiensis*, microhabitat differences among life stages are not well documented. The authors evaluated microhabitat use of larval, subadult and adult *C. alleganiensis* at three streams in east Tennessee by comparing sites occupied by *C. alleganiensis* to random sites within each stream. Multivariate analysis was used to evaluate microhabitat use differences among larval, subadult and adult *C. alleganiensis*. Habitat assessments were completed for 60 individuals. The authors detected an association between *C. alleganiensis* presence (regardless of life stage) and the percentage of large rock, the percentage of low embedded rocks, and the number of rocks above 500 mm. Furthermore, the volume of cover rock, the number of rocks above 500 mm, the distance to bank, and the percentage of low embedded rocks, gravel, and sand were the most important microhabitat attributes to discriminate life-stage distributions. Overall, the analyses identify microhabitat attributes that are potentially important for long-term *C. alleganiensis* conservation and provide guidance for stream protection and restoration practices that might mitigate sedimentation and habitat degradation in impacted streams.

SPATIAL ECOLOGY OF EASTERN COPPERHEADS

M. V. Novak et al. [2020, *Journal of Herpetology* 54(1):97-106] quantified and compared movement and microhabitat use of eastern copperheads (*Agkistrodon contortrix*) in fragmented and unfragmented habitats to determine the effects of fragmentation on movement and habitat use. Thread bobbins were used to track movement and calculate straight-line distance (SLD) moved, total distance (TDM) moved, and occupied area for individual snakes. Microhabitat use was characterized by quantifying number of trees, woody vegetation stems, herbaceous vegetation stems, percent grass coverage, and percent canopy coverage at each location a snake was observed, and at an equal number of randomly selected locations. Neither SLD nor TDM differed between fragmented and unfragmented habitats. Overall average SLD moved was 24.1 m and TDM was 39.6 m over 48 h. Although SLD and TDM did not differ between sites, mean occupied area $\pm$ standard error was significantly greater at the unfragmented ($2,310.9 \pm 272.7$ m) compared with the fragmented site ($1,025.9 \pm 314.9$ m). Microhabitat features were similar between the fragmented and unfragmented sites, and herbaceous vegetation and high canopy cover were associated with locations where snakes were observed at both sites. It is likely that eastern copperheads can persist in a variety of habitats in the southeastern United States because their preferred microhabitat features are widely distributed and common in both fragmented and unfragmented environments, demonstrating that they retain characteristics of a habitat specialist within heterogeneous environments suitable for generalists.

GARTERSNAKES AND ECOPASSAGES

R. M. Dillon et al. [2020, *Journal of Herpetology* 54(1):19-23] note that the negative effects of roads on wildlife have been well studied, and their mitigation is considered of critical importance to conservation. Mitigation of these threats commonly incorporates exclusion fencing and landscape connectivity structures, but the mechanics of mitigation success and species-specific responses are poorly understood. Eastern gartersnakes (*Thamnophis sirtalis sirtalis*) are an ubiquitous species and frequently victims of road mortality, so the authors conducted a “willingness to utilize” (WTU) experiment to understand snake behavior when interacting with ecopassages. Snakes were exposed to newly installed ecopassages at Presqu’ile Provincial Park (10 m long $\times$ 0.5 m wide $\times$ 0.32 m tall). Naïve snakes and snakes with ecopassage experience were introduced to one of two arena options: 1) a completely closed-in arena, only allowing snakes to enter the ecopassage, or 2) a similar arena with two exits allowing snakes to bypass the ecopassage, more reflective of a real-life scenario. All snakes entered the ecopassage when given no other option. When given options to bypass the ecopassage, at least 59% of snakes still chose to enter the ecopassage, regardless of trial design or prior ecopassage experience, suggesting that in general, there is neither aversion nor attraction to ecopassages. Most snakes made their choice within 30 sec and neither temperature nor traffic affected crossing duration; however, experienced snakes crossed the ecopassage faster than naïve snakes. This study shows the use of a common mitigation structure by a widespread species and supports how these mitigation efforts are ultimately increasing our ability to successfully mitigate negative road-effects.

DECLINE IN A CAIMAN POPULATION

D. A. Ortiz et al. [2020, *Journal of Herpetology* 54(1):31-38] point out that knowledge on long-term population trends in crocodilians is essential to assess the effectiveness of conservation areas and to guide sustainable management practices. They studied changes in population size of spectacled (*Caiman crocodilus*) and black caimans (*Melanosuchus niger*) over a period of 17 yr at Mateococha, a black-water lake located in Cuyabeno Wildlife Reserve, western Amazonia, Ecuador. Using standardized spotlight counts and two mark–recapture surveys, they estimated the population abundance, body size structure, and sex ratio in 1994, 2004, and 2011. The maximum number of *C. crocodilus* recorded in 1994 (147 individuals; 33 individuals/kilometer [ind/km] of lakeshore) declined by 2004 to 94 individuals (21.1 ind/km) and by 2011 to 63 individuals (14.2 ind/km). The number of *M. niger* recorded was low but constant (5–7 individuals; 1.1–1.6 ind/km) throughout the study, suggesting that factors causing the decline in *C. crocodilus* were not related to the *M. niger* population trend. Large *C. crocodilus* adults (total length 150–220 cm) were frequent in 1994 but became rare in 2004 and 2011. The sex ratio of captured *C. crocodilus* was male-biased during all periods. The causes of the population decline are unknown, but available evidence suggests that illegal hunting and habitat degradation are likely culprits despite the protected status of the Cuyabeno Reserve. These findings question the effectiveness of protected areas to ensure long-term survival of caiman populations in Ecuador.

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For sale: *Tropical Queensland*; 1970; 262 pp., 9 × 12", and *Australia's North*; 1975; 208 pp. Both written by Stanley and Kay Breeden from an ecological perspective and representing many months in the field. Many outstanding color and b&w photos, some full and double page, of reptiles (geckos, skinks, monitors, agamids, pythons, elapids, crocodiles), birds, mammals, frogs, insects, trees, flowers. Mylar-covered DJ—\$37 each; Ross Allen's Reptile Institute memorabilia circa 1954; 8 pp. price list (six foot indigo snake- \$10); 59 pp. photo-illustrated catalog (Bill Alcorn's snake boots - \$39.95); postcard (one cent postage); 8 panel pamphlet of history of Ross Allen and his Institute; 2 pp. 1955 newsletter—\$24; *The Cold-blooded Australians* by Gunther Schmida; 1985; 208 pp., 8½ × 12", illustrated with excellent color photos of geckos, monitors, skinks, pythons, elapids, turtles, crocodiles, fish and frogs, among others, many full page taken in the critters' natural habitat; Mylar-covered DJ—\$22; *New Zealand Amphibians & Reptiles* by Joan Robb (first edition); 128 pp., 32 color plates, range maps; Mylar-covered DJ—\$50. Items sent postpaid. Books hardbound and in excellent condition. Email for complete list. William Turner, (303) 795-5128, toursbyturner@aol.com

For Sale: Four custom-built fiberglass enclosures, 6½ feet long by 5 feet wide by 18 inches high, with platform bases included (see photos below). Perfect for turtles, tortoises, crocodilians, aquatic critters, etc. Original cost \$835.00 each plus shipping cost from China. Willing to sell all four with the bases for \$1,600.00. Robert Krause bobkrause001@gmail.com.



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UPCOMING MEETINGS

Until in-person meetings again become possible the Chicago Herpetological Society will begin having monthly general meetings online via Zoom Webinar. These meetings will take place on the last Wednesday of each month at 7:30 P.M. Chicago time. Find information about attending a Zoom Webinar here:

<[https://support.zoom.us/hc/en-us/articles/115004954946-Joining-and-participating-in-a-webinar-attendee->](https://support.zoom.us/hc/en-us/articles/115004954946-Joining-and-participating-in-a-webinar-attendee-)

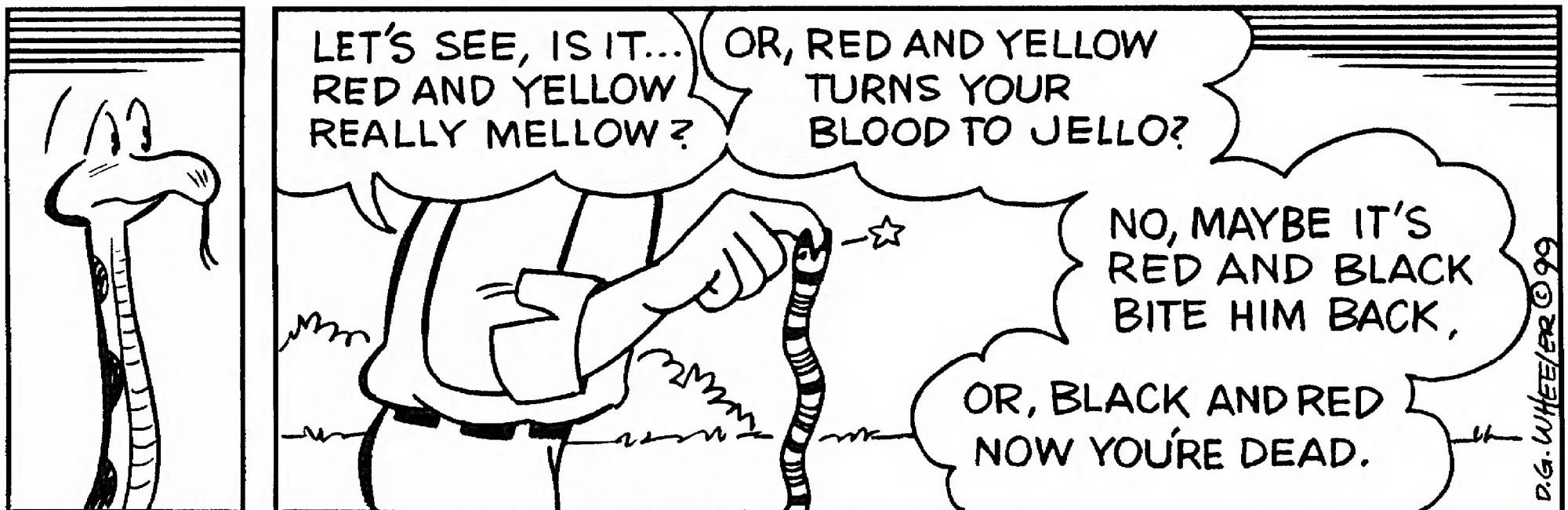
The next meeting will take place via Zoom on September 30. This will be a Show and Tell meeting where members are welcome to give a brief 2–5 minute presentation of an animal of their choice. You do not have to present an animal or be a member of the CHS in order to watch the webinar.

If you would like to present an animal during the meeting, please email akolb@chicagoherp.org. A list with the presentation order and instructions for participants will be emailed to all presenters before the meeting. Please email with your intent to present at least 24 hours before the meeting.

Board of Directors Meeting

Are you interested in how the decisions are made that determine how the Chicago Herpetological Society runs? And would you like to have input into those decisions? The next board meeting will be held online. If you wish to take part, please email akolb@chicagoherp.org.

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